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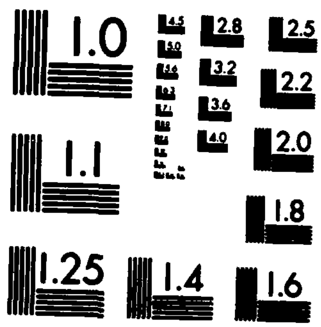
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(CNA)79-0526
30 March 1979

MEMORANDUM

COD/VOD AIRCRAFT CANDIDATES (U)

CDR John J. Seeberger
Nancy L. Spruill
John A. Berning, Jr.

INSTITUTE OF NAVAL STUDIES

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Enclosure (1) to CNA ltr Ser (CNA)79-0526 of 14 April 83

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30 March 1979

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Encl: (1) (CNA)79-0526, "COD/VOD Aircraft Candidates (U)," Confidential, 30 March 1979

Enclosure (1) is forwarded for your review. If you have any comments, please address them to CDR John Seeberger in writing or by phone (OX5-9241, ext. 368) no later than April 13.

Nancy L. Spruill
NANCY L. SPRUILL
Study Director
COD/VOD Study

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COD/VOD AIRCRAFT CANDIDATES

As part of the CNO Studies and Analyses Program FY 1978, the Center for Naval Analyses is conducting a COD/VOD Requirements and Forces Study. One of the tasks to support the CNO Study Directive is to determine the candidate aircraft and obtain performance characteristics and cost information. This memorandum provides the data on those aircraft.

BACKGROUND

Present COD/VOD forces consist of: 32 aging C-1A aircraft, assigned to both carriers and COD squadrons (VRC), that will reach the end of their useful service life in the mid-1980s; 10 C-2A aircraft, assigned to VRC squadrons, whose service life are being extended through the 1980's through a Service Life Extension Program (SLEP) which began in FY 77; and a VOD detachment of 3 RH-53D helicopters. Table 1 summarizes the planned operating inventory of COD/VOD aircraft through FY 89. To this fleet the Navy is planning to add a force of 16 CH-53E helicopters to be used for the VOD mission starting in FY 82. Because of the restricted range capability, VOD is generally considered an augmentation to COD. A replacement COD aircraft is a firm but as yet unsatisfied requirement.

The COD aircraft requirements have been debated for several years. The DoD and Congress have generally agreed that the COD/VOD mission is valid. They have argued primarily about the aircraft

TABLE 1

PLANNED OPERATING INVENTORY OF COD/VOD AIRCRAFT THROUGH FY 1989

COD aircraft	Fiscal year									
	80	81	82	83	84	85	86	87	88	89
C1A (ship)	12	11	8	3	-					
C1A (VRC Sqd)	20	20	20	20	16	10	8	6		
C2A (VRC Sqd)	10	10	10	10	9	8	8	8	8	6
Totals	42	41	38	33	25	18	16	14	8	6
VOD aircraft										
RH-53D	3	3	3	3						
CH-53E			2	16	16	16	16	16	16	16
Totals	3	3	5	19	16	16	16	16	16	16

NOTE: Results of a fatigue analysis (Structural Appraisal Fatigue Effects Program) being conducted by NARF Jacksonville will indicate the feasibility, cost, extent of any modifications, and length of service life extension for the C1A aircraft.

characteristics required to accomplish the COD mission (i.e., range, payload). The basic issue of the argument is the type, mix and cost of aircraft required to provide adequate COD/VOD support.

CANDIDATE AIRCRAFT

Due primarily to the requirement to have a carrier-suitable aircraft, prior investigations have concluded that the least expensive fixed wing aircraft candidates are derivatives of existing carrier-based aircraft. In 1972, interested contractors were invited to prepare designs which could meet COD requirements, with emphasis on derivative designs, reduced costs and wide range of capabilities. Twenty-four responses were received, ranging from the Beech Air King (weight 15,000 pounds, range 600 nautical miles, 4,000 pound payload) to a Lockheed C-130 (weight 124,000 pounds, range 2,200 nautical miles, 16,000 pound payload). All 24 proposals were evaluated and it was concluded that derivatives of the carrier qualified C-2 and S-3 aircraft were the only economically feasible alternatives because of the limited number of aircraft required. Derivatives of the C-2 and S-3 continue to be viable COD candidates. For conceptual advanced technology aircraft the introduction of a VSTOL COD as a derivative of the basic VSTOL Type A family is a viable candidate for after 2000.

The candidate aircraft in this study are: two existing helicopters, the RH-53D and the CH-53E; four derivatives of existing fixed wing aircraft, the improved C-2, the C-2 model 673, the US-3A and the S-3 COD; and four derivatives of the conceptual

advanced technology aircraft, a conventional take-off and landing aircraft (CTOL), and derivatives of three VSTOL Type A aircraft, a lift cruise fan (LCF), a tilt rotor (TR) and an advancing blade concept (ABC).

In our analysis we will conduct two solutions; the best number and mix of all the candidate aircraft and those aircraft after excluding the advanced technology aircraft. The COD/VOD aircraft candidates must be investigated in these two sets since the initial operating capability (IOC) of the advanced technology aircraft will be after 2000. The immediate concern to the Navy is to address the COD shortfall of the next 15 to 20 years.

We worked with the Naval Air Systems Command (NASC) in obtaining aircraft performance characteristics and the cost information. All cost information presented in this memorandum is category F (not budget quality).

EXISTING AIRCRAFT DERIVATIVES

The existing aircraft derivatives include the improved C-2, the C-2 model 673, the US-3A, the S-3 COD, the RH-53D and the CH-53E. Performance characteristics and cost data are summarized in tables 2 and 3 respectively. Table 3 includes investment costs for procurement lots of 12, 24 and 36 aircraft and the associated Life Cycle Costs (LCC). In addition to the undiscounted costs, discounted costs (10 percent rate) are presented for comparison.

Configurations of each of the fixed wing aircraft have been evaluated in the past. To eliminate confusion regarding the exac

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TABLE 2

CANDIDATE COD/VOD AIRCRAFT CHARACTERISTICS
(EXISTING AIRCRAFT DERIVATIVES)

	Improved C-2 with tanks	Improved C-2	C-2 Model 673[a]	US-3A w pods	US-3A w/o pods[a]	S-3 COD	RH-53D	CH-53E
rformance:								
oss payload (lbs)	10,000	10,000	10,000	6,510	4,590	10,000	-	-
ading equipment (lbs)[b]	1,500	1,500	1,500	760	760	997	-	-
t payload (lbs)	8,500	8,500	8,500	5,750	3,830	9,003	-	-
nge (n.m.)	1,580	1,280	1,980	2,040	2,790	1,875	-	-
ternal payload (lbs)[c]								
500 n.m. range	-	-	-	-	-	-	6,600	18,600
300 n.m. range	-	-	-	-	-	-	9,900	24,000
ternal payload (lbs) 50 n.m. range	-	-	-	-	-	-	15,600	32,000
uise speed (kts)	245	241	248	343	335	338	135	135
rgo volume (ft^3)	675	675	675	450	270	665	1,462	1,462
gine carrying capacity[d]	Yes	Yes	Yes	No	No	Yes	Yes	Yes
ssenger capacity	28	28	28	5	5	22	38	55
load-plus-load time (min)[b]	42	42	42	20-40	20-40	30	20	20
ailability:								
ailability (A_o) (%)[ef]	65	65	65	88	88	85	75	85

FOOTNOTES TO TABLE 2

[a]Two external 300 gal tanks.

[b]Approximated by NASC.

[c]Payload cube considered critical factor.

[d]Engine weight and cube determining factor in capacity.

[e]US-3A actual rate, contractor estimate for C-2 derivatives and S-3COD.

[f]Estimated for RH-53D assigned VOD mission, production release goal for CH-53E.

TABLE 3

AIRCRAFT COST ESTIMATES
(EXISTING AIRCRAFT DERIVATIVES)

	Improved C-2	C-2 Model 673	US-3A	S-3 COD	RH-53D	CH-53E
Undiscounted Costs						
Investment (CAC, $M)						
for 12	18.8	31.8	26.7	47.0	-	12.66
for 24	16.8	24.2	21.9	34.1	-	12.66
for 36	16.0	21.4	19.6	28.7	-	12.66
Operating and Support (20 Yr, $M)	19.4	19.8	18.6	20.6	28.6	31.8
20 Yr Life Cycle Cost ($M)						
for 12	38.2	51.6	45.3	67.6		44.5
for 24	36.2	44.0	40.5	54.7		44.5
for 36	35.4	41.2	38.2	49.3	(28.6)	44.5
Discounted Costs						
Investment (CAC, $M)						
for 12	18.7	30.3	26.6	45.1	-	12.66
for 24	16.0	21.8	21.0	31.1	-	12.03
for 36	14.6	18.4	18.1	25.1	-	11.44
Operating and Support (20 Yr, $M)	8.5	8.7	8.2	9.0	12.6	14.0
20 Yr Life Cycle Cost ($M)						
for 12	27.2	39.0	34.8	54.1		26.7
for 24	24.5	30.5	29.2	40.1		26.0
for 36	23.1	27.1	26.3	34.1	(12.6)	25.4

NOTES TO TABLE 3

1. For buys of size 12 and 24, 20% of the support and spare cost for the 2nd and 3rd year, respectively, is included as part of the support and spaces (basic cost found in table 4)

2. A 10% rate of discount is assumed (corresponds to 11.1% rate of interest).

3. The discounted values are calculated as follows:

Using the US-3A with a buy of 36 as an example, the operating and support is

$$.92 + (1-.10)^1(.93) + (1-.10)^2(.93) + (1-.10)^3(.93) + \ldots$$
$$+ (1-.10)^{19}(.93) = 8.2$$

the investment cost is

$$[(273.2 + 41.2) + (1-.10)^1(179.8 + 27.2) + (1-.10)^2(160.5 + 24.2)]/36$$
$$= 18.1;$$

thus, in particular, it is assumed that all payments in a year are made at the beginning of that year.

configurations considered in this study the NASC configured each derivative as defined in appendix A. These configurations were then used by the NASC to develop the cost information and performance characteristics. Procurement schedules and investment costs calculated for the fixed wing aircraft are found in table 4. Supporting information for the development of the O&S costs is found in appendix B.

A few brief comments are appropriate for each of these aircraft candidates:

o RH-53D's are currently in the fleet, three supporting the VOD mission with the rest supporting minesweeping The three VOD aircraft will return to the minesweeping mission when the eight CH-53Es are based at Sigonella.

o CH-53E's are currently being procured, however, those planned for the VOD mission will not be available until FY 82. The basing for the CH-53E's is scheduled as follows: Sigonella 8, Cubi Point 5, and Naples 3.

o The improved C-2 is similar to the C-2A, the main improvements include the T56-A-425 engines and use of corrosion resistent materials. Two external fuel tanks can be attached to the Improved C-2 to increase its range by 300 n.m. We will also consider this variation of the Improved C-2. In most cases these tanks, which can be jettisoned but are not removable, pose no problem. However under some conditions they may. NASC provided us with the following information.

TABLE 4

BASIC PROCUREMENT SCHEDULES AND INVESTMENT COSTS FOR EXISTING AIRCRAFT DERIVATIVES

PROGRAM YEAR 1979 DOLLARS IN MILLIONS

					Total
US-3A		(12)	(12)	(12)	(36)
Flyaway		273.2	179.8	160.5	613.5
Support & Spares		41.2	27.2	24.2	92.6
Investment Cost		314.4	207.0	184.7	706.1
"Fat Albert"	(4)	(8)	(12)	(12)	(36)
FLyaway	296.4	187.9	221.3	193.6	899.2
Support & Spares	44.7	28.4	33.4	29.2	135.7
Investment Cost	341.1	216.3	254.7	222.8	1,034.9
C-2 Update		(12)	(12)	(12)	(36)
Flyaway		191.6	155.0	154.5	501.1
Support & Spares		28.9	23.4	23.3	75.6
Investment Cost		220.5	178.4	177.8	576.7
Design 673	(3)	(9)	(12)	(12)	(36)
Flyaway	177.4	149.4	173.2	170.5	670.5
Support & Spares	26.8	22.6	26.2	25.7	101.3
Investment Cost	204.2	172.0	199.4	196.2	771.8

NOTES:

1. Category "F" estimates

2. R&D costs for Fat Albert and Design 673 are included in the flyaway costs

> "The fully-loaded gross weight of the Improved C-2A with 10,000 lbs. payload and without tanks is 56,888 lbs. At this weight, on a tropical day, gear down, flaps 20°, single engine flight is not practically possible.
>
> "Single engine flight in this configuration is feasible by reducing payload. To realize a 100 fpm rate of climb for the above conditions, for example, 3900 pounds of cargo must be off-loaded.
>
> The addition of two three hundred gallon tanks with associated fuel will increase the range approximately 300 n.m. With full fuel and 10,000 lb. payload, the gross weight is increased to 61,800 lb. However, at this weight, for the conditions stated, the aircraft cannot sustain flight on one engine (rate of climb is -220 fpm). To obtain a 100 fpm rate of climb with full internal and external fuel, 8,800 pound of cargo of cargo must be off-loaded.

For the Improved C-2 without tanks NavAir also noted that 3,900 lbs. of cargo should be off-loaded in order to achieve 100 fpm single engine rate of climb (for the previous maintained conditions).

o The C-2 model 673 incorporates all the changes for the Improved C-2 plus more. The changes include the two external 300-gallon fuel tanks, increased internal fuel, provisions for inflight refueling and changes in wing and engine positioning. The purpose of most of these additional changes is increased range.

o The US-3A is very similar to the one now in use on the West Coast (3007).

o The S-3 COD, previously called "Fat Albert," includes a longer and wider body and a cargo ramp loading door enabling the aircraft to carry out-sized cargo including aircraft engines.

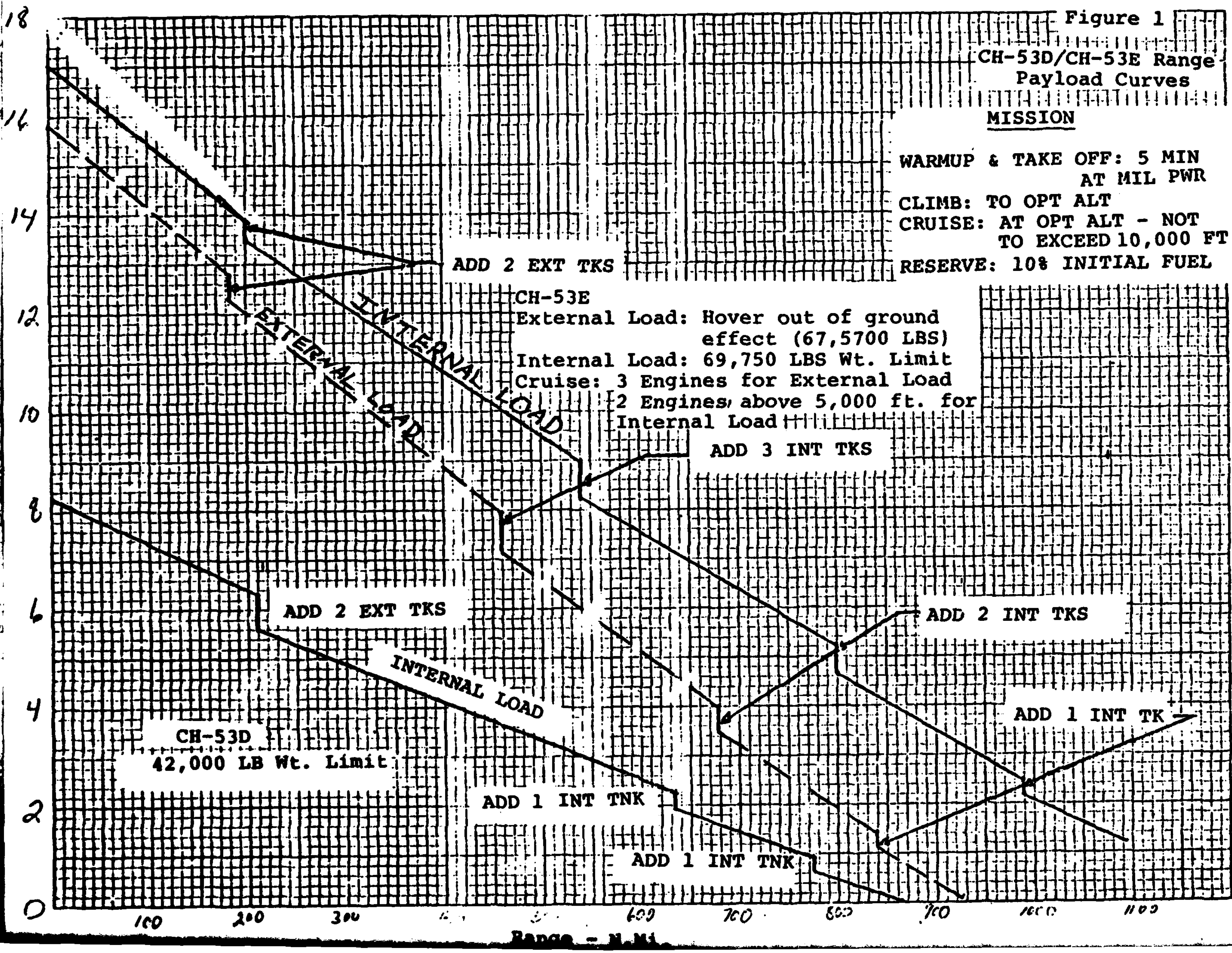
For the fixed wing candidates the range is little affected by the payload. However, for the helicopters there is a strong rela-

tionship between payload and range (figure 1). In the case of the helicopters the payload cube is believed to be the critical factor in terms of what they can carry. The helicopters have the capability to carry external cargo short distances. The US-3A is the only candidate aircraft that cannot carry any engines, however, whether a specific engine can be carried or not and how many engines can be carried depends on the weight and cube of the particular engine. The availabilities listed in table 2 are in the case of the US-3A the actual Operationally Ready (OR) rate for the one US-3A. For the other fixed wing aircraft they are contractor estimates provided by NavAir. The RH-53D availability represents an estimate of this helicopter's operation in the VOD mission and that for CH-53E is a production release goal.

The costs listed in table 3 are category "F". For the C-2 Mod 673 and the S-3 COD the Research and Development (R&D) costs are included in the investment costs, given as cumulative average cost. The costs have been calculated for the fixed wing aircraft based on procurements of 12, 24, and 36 aircraft. The O&S costs are dollars per aircraft per year. Both the undiscounted and discounted 20-year life cycle costs for procurements of 12, 24 and 36 aircraft are shown in table 3.

CONCEPTUAL ADVANCED TECHNOLOGY AIRCRAFT

Performance data on the conceptual aircraft addressed in this memorandum were obtained from the technical data published by NavAir in December 1978 as part of the Sea Based Air Master Study (SBAMS) Aircraft Alternative Definition Task. The four design fa-



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milies, one conventional and three VSTOL Type A for which performance characteristics and cost information are provided in table 5 are: CTOL (high speed), L/CF (high speed), TR (medium speed) and ABC (low speed). The projected IOC of these types of aircraft is after year 2000.

- The CTOL aircraft is smaller than the S-3, has a low wing, and has engines mounted oh each side of the fuselage behind the wing.
- The L/CF aircraft is similar in size to the CTOL, but large nacelles blended into the fuselage under the high wing are required for the engines over five foot diameter tandem fans. Development is required for the lift fan.
- The TR aircraft fuselage is also similar to that of the CTOL, with a shorter high wing, and at each wing tip a nacelle and rotor can be tilted from vertical (for vertical lift) to horizontal (for horizontal flight propulsion).
- The ABC helicopter has two coaxial contrarotating rigid rotors for lift and a tail pusher propeller for higher speed propulsion.

The different design families are shown in figures 2 through 5.

Range vs. payload curves for the conceptual aircraft candidates are found in figures 6 through 9. Table 6 lists annual O&S cost data (for both current and advanced technology).

TABLE 5

CONCEPTUAL AIRCRAFT COD/VOD CHARACTERISTICS

STO Mission	Hi speed CTOL	VSTOL Hi speed L/CF	VSTOL Med speed TR	VSTOL Low speed ABC
Max payload (lb)	6,237	6,202[a]	6,983[a]	--
Range at max payload (nm)	1,800	1,620[a]	1,460[a]	--
Range at 2000 lbs payload (nm)	2,540[a]	1,840[a]	2,170[a]	--
Payload (lbs)[b]				
300 nm range	--	--	--	15.500
800 nm range	--	--	--	8,800
Cruise speed (kts)	365	380	322	155
Cargo volume (ft^3)	640	640	640	834
Engine carrying capacity[c]	Yes	Yes	Yes	Yes
Passenger capacity	18	18	18	18
Availability[d] (%)	90	84	84	84
Costs (FY 79 $M)[e]				
RDT&E (for 56 acft)	171	228	72	39
Investment (CAC for 56 acft)	13.6	21.4	14.8	14.2
O&S ($/acft/yr)[d]	.591	.875	.708	.743

Source: Sea Based Air Master Study, Aircraft Alternatives Definition Task, Phase I Report (U), December 1978, NASC, Confidential.

Definitions:

CAC - cumulative average cost
Acft - aircraft
STO - short take off
O&S - operating and support
RDT&E - research, development, test and evaluation

FOOTNOTES TO TABLE 5

[a]Includes two external 400 gallon tanks.

[b]Payload cube is the critical factor.

[c]Assumes engines to be modular.

[d]Provided by Air-4105B.

[e]Ground rules in development of cost data for COD derivative

1. One flight test aircraft
2. The small body VSTOL is developed first with the COD aircraft being a mission variant of either Marine Assault or Missileer which will be the first wide body VSTOL basic aircraft system configuration.
3. The total number of aircraft for the types of VSTOL is different and varies as stated in the Sea Based Air Master Study. Costs reflect procurement numbers and schedule of the study.
4. The RDT&E costs listed are only the COD peculiar costs.
5. Flight Hour Utilization is 30 hr/mo.
6. O&S costs reflect advanced technology (significant improvements in reliability and maintainability).

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TABLE 6

ANNUAL COST PER AIRCRAFT
SEA BASED AIR MASTER STUDY
AIRCRAFT OPERATIONS & SUPPORT COST - COD MODALITY

	AIRCRAFT CONFIGURATIONS					
COST ELEMENTS	STOVL A H.S. COD	STOVL A* H.S. COD	STOL A H.S. COD	STOL A* H.S. COD	CTOL A H.S. COD	CTOL A* H.S. COD
PERSONNEL, OFFICER	102,033	102,033	102,033	102,033	68,022	68,022
PERSONNEL, ENLISTED	289,680	55,163	199,708	37,759	226,454	39,824
TOTAL PERSONNEL	391,713	157,196	301,741	139,792	294,476	107,846
AIRFRAME REWORK	85,748	85,603	49,492	49,445	58,410	58,359
ENGINE OVERHAUL	15,321	15,321	25,869	25,869	22,690	22,690
AVIONICS - OTHERS	84,654	84,798	84,744	84,844	84,726	84,841
DEPOT MAINTENANCE TOTAL	185,723	185,802	109,367	108,421	120,446	120,510
REPLENISHMENT SPARES	147,420	147,420	127,530	127,530	134,204	134,204
OPERATING CONSUMABLES - POL	97,462	97,462	94,032	94,032	64,864	64,864
OPERATING CONSUMABLES - OTHER	128,635	24,487	88,707	16,790	100,598	17,890
AIR TAD	20,000	20,000	20,000	20,000	20,000	20,000
DIRECT COST - TOTAL	971,003	632,367	740,377	506,565	734,588	465,114
INDIRECT COST - TOTAL	262,170	170,739	199,901	136,772	198,338	125,530
TOTAL AC OPERATIONS COST ANNUAL	1,233,173	803,106	940,278	643,337	932,926	590,594
COST PER FLIGHT HOUR	3,426	2,231	2,612	1,787	2,592	1,641

* ADVANCED TECHNOLOGY

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TABLE 6 (Cont'd)

ANNUAL COST PER AIRCRAFT
SEA BASED AIR MASTER STUDY
AIRCRAFT OPERATIONS & SUPPORT COST - COD MODALITY

	AIRCRAFT CONFIGURATIONS					
COST ELEMENTS	VSTOL A M.S. COD	VSTOL A* M.S. COD	VSTOL A M.S. COD	VSTOL A* M.S. COD	VSTOL A L.S. COD	VSTOL A* L.S. COD
PERSONNEL, OFFICER	102,033	102,033	102,033	102,033	102,033	102,033
PERSONNEL, ENLISTED	295,137	55,655	248,382	56,441	223,209	50,148
TOTAL PERSONNEL	397,220	157,688	350,415	158,474	325,242	152,181
AIRFRAME REWORK	94,658	94,593	70,758	70,704	58,996	58,950
ENGINE OVERHAUL	63,846	63,846	29,224	29,224	3,470	3,470
AVIONICS - OTHERS	84,650	84,798	83,257	83,376	84,448	84,556
DEPOT MAINTENANCE TOTAL	243,154	243,237	124,791	124,856	139,374	140,036
REPLENISHMENT SPARES	148,258	148,258	133,376	133,376	140,130	140,130
OPERATING CONSUMABLES - POL	94,885	94,885	95,763	95,763	110,224	110,224
OPERATING CONSUMABLES - OTHER	131,133	24,739	110,343	25,088	99,151	22,287
AIR TAD	20,000	20,000	20,000	20,000	20,000	20,000
DIRECT COST - TOTAL	1,034,650	688,807	834,698	557,557	834,721	584,858
INDIRECT COST - TOTAL	279,355	185,977	225,365	150,540	225,374	157,911
TOTAL AC OPERATIONS COST ANNUAL	1,314,005	874,784	1,060,053	708,097	1,060,095	742,769
COST PER FLIGHT HOUR	3,650	2,430	2,945	1,967	2,945	2,063

* ADVANCED TECHNOLOGY

A/C Category: TYPE A CTOL

A/C Concept: TURBOFAN

Mission Variants: COD
AAW (MISSILEER)

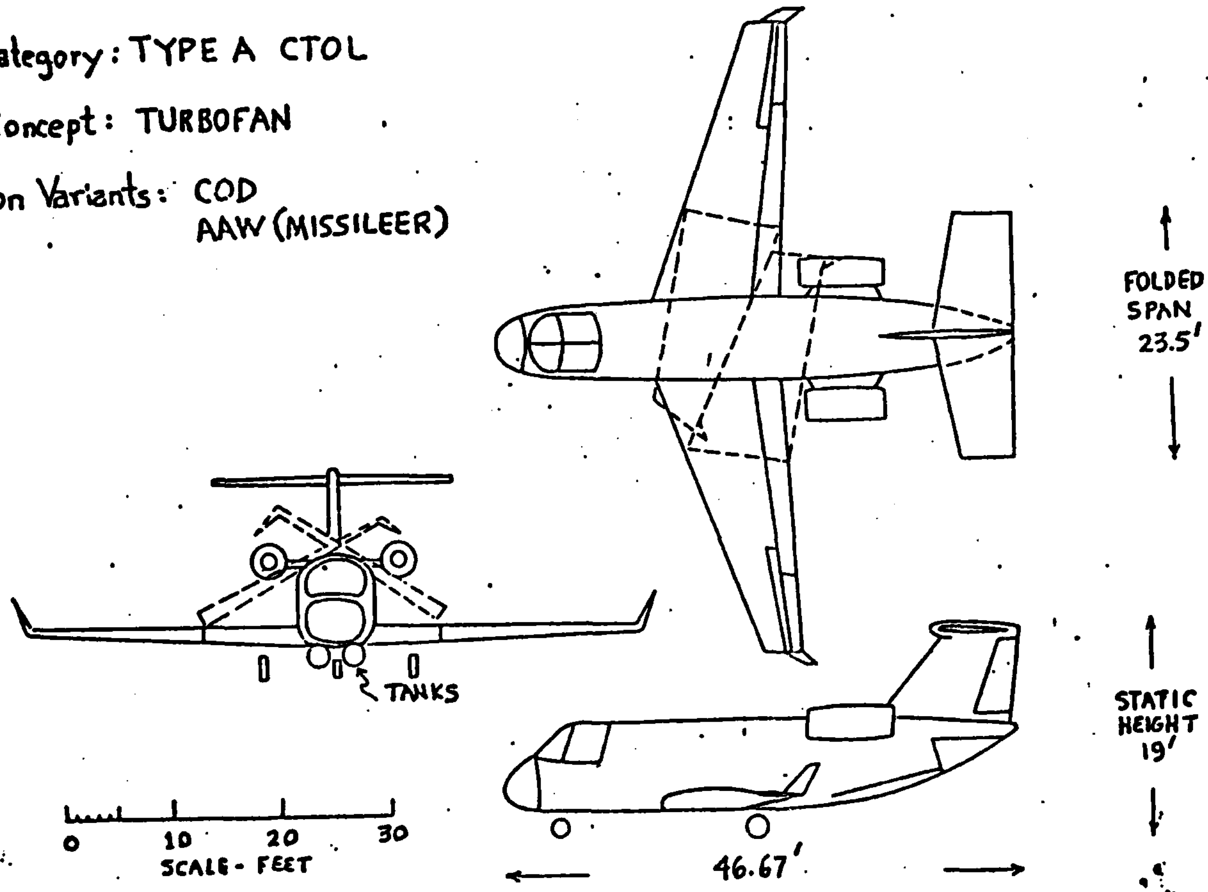


Fig. 2: CTOL

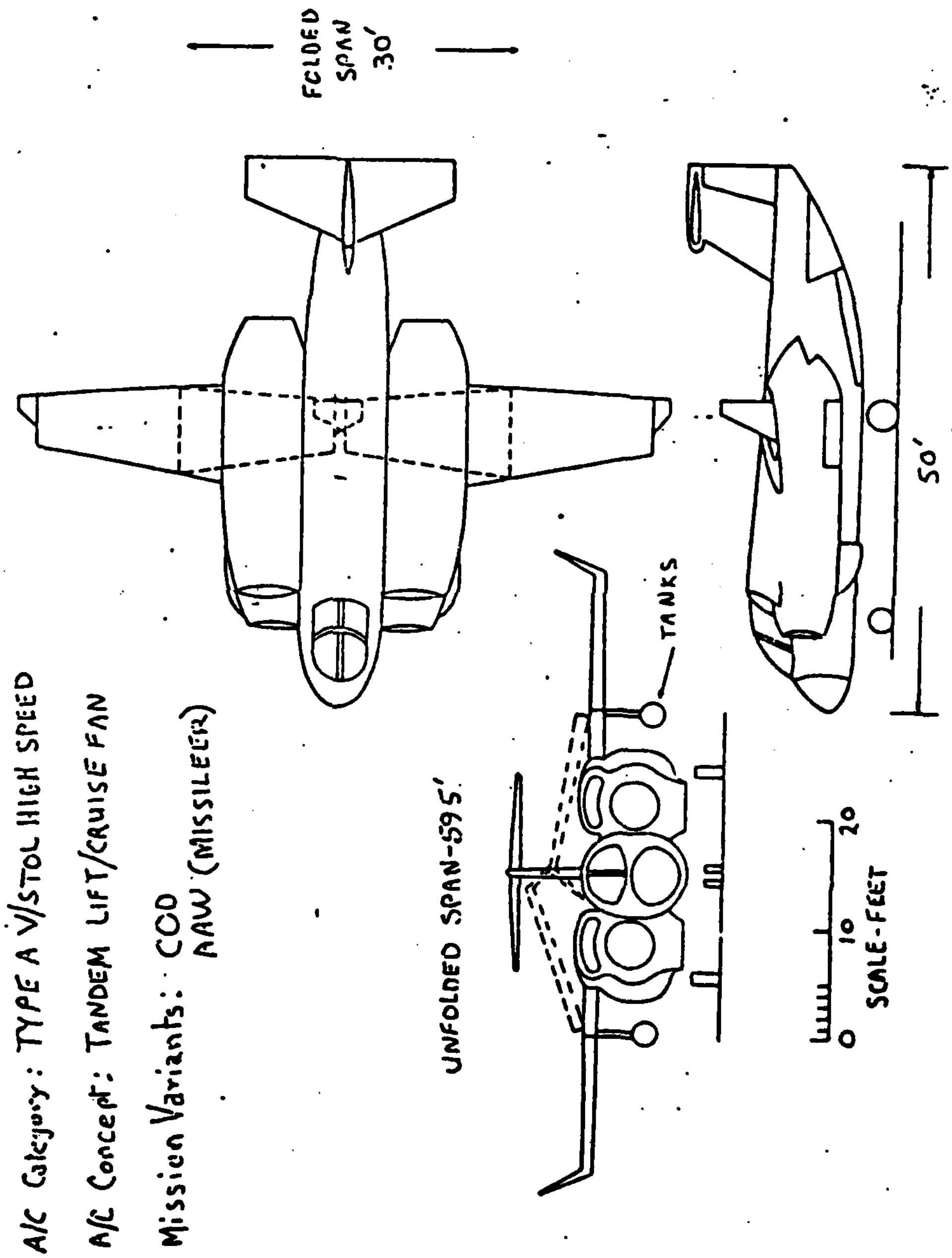


Fig. 3: Lift/Cruise Fan

A/C Category: TYPE A V/STOL MEDIUM SPEED

A/C Concept: TILT ROTOR

Mission Variants: COD
VOD
MA
AAW (MISSILEER)

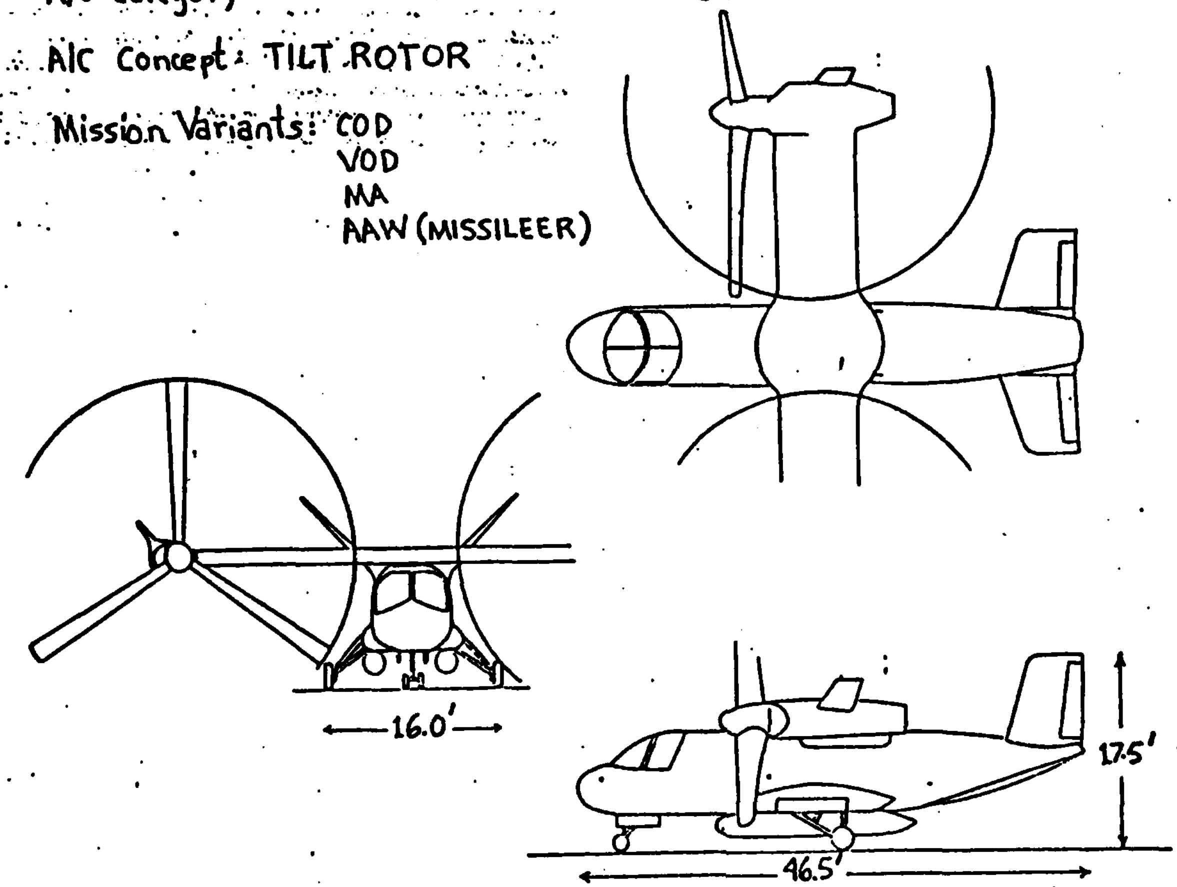


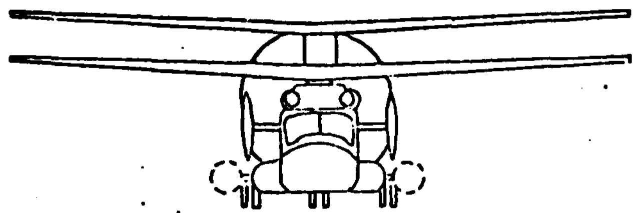
Fig. 4: Tilt Rotor

A/C Category: TYPE A V/STOL LOW SPEED

A/C Concept: ADVANCING BLADE CONCEPT

Mission Variants: MA
COD

	Operating	Folded	
Length	58.5	47.5	Feet
Width	56.0	14.0	Feet
Height.	17.5	16.5	Feet



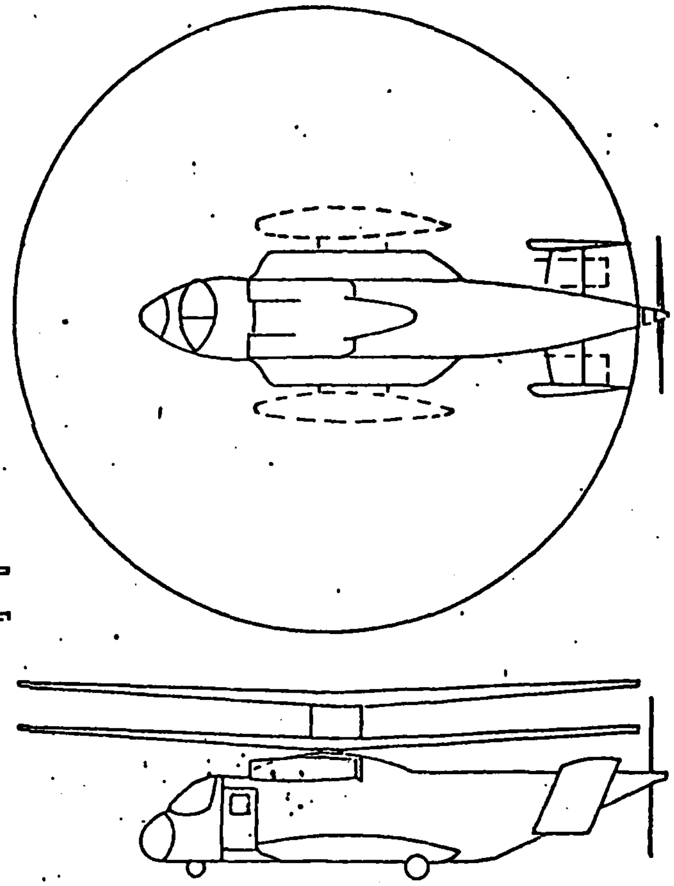
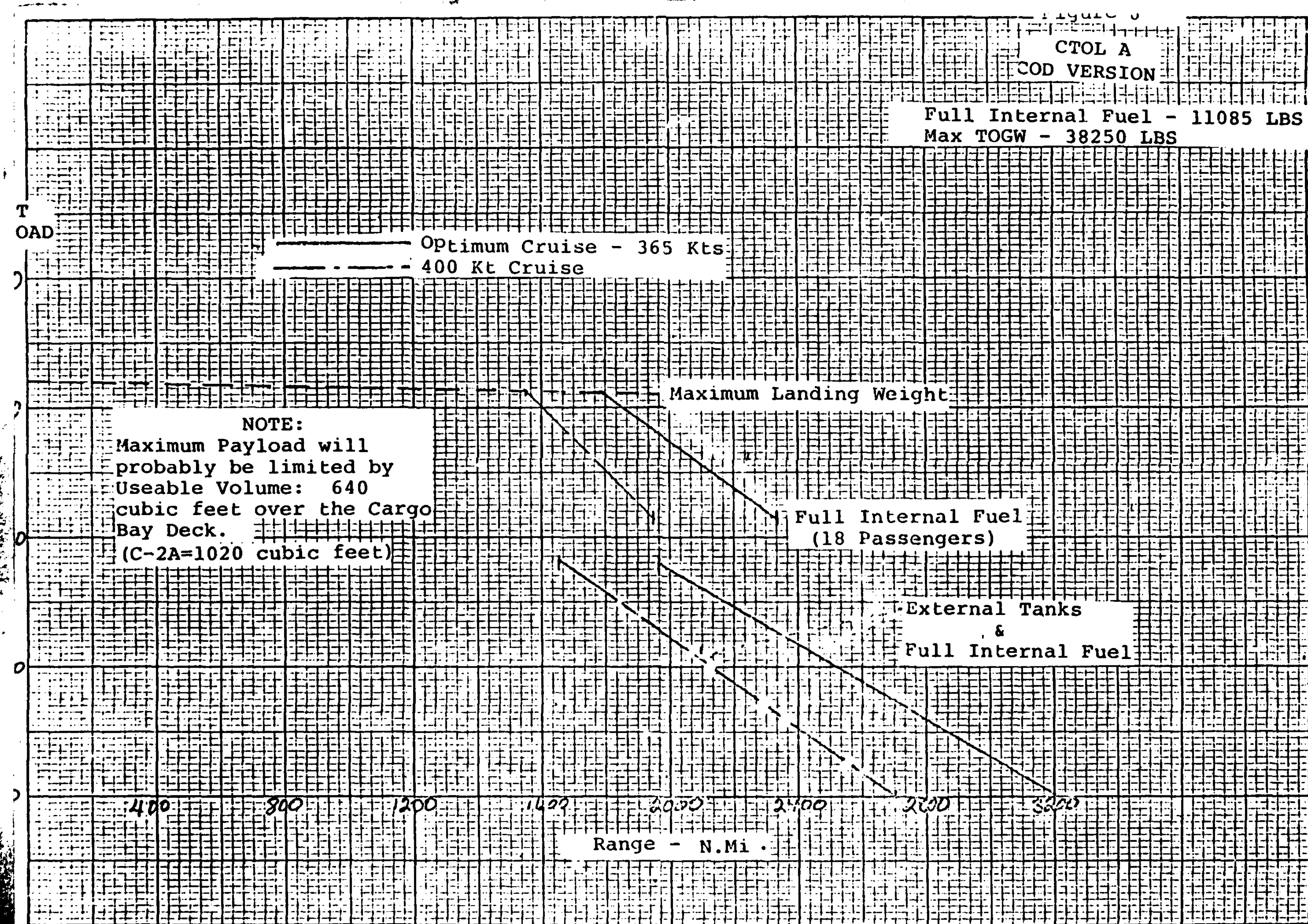
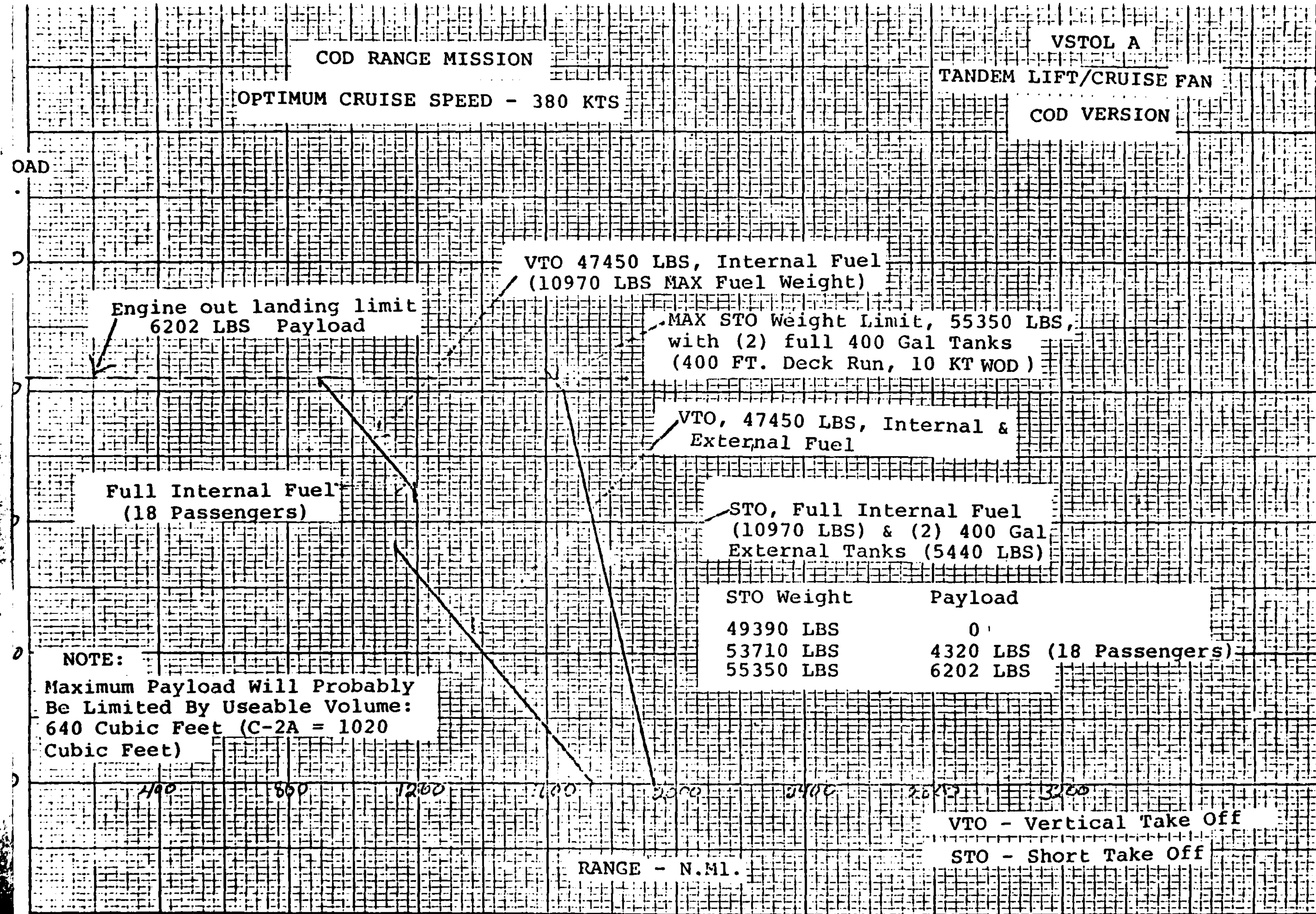


Fig. 5: Advancing Blade Concept


CTOL A
COD VERSION
Full Internal Fuel - 11085 LBS
Max TOGW - 38250 LBS
T
OAD
Optimum Cruise - 365 Kts
400 Kt Cruise
Maximum Landing Weight
NOTE:
Maximum Payload will
probably be limited by
Useable Volume: 640
cubic feet over the Cargo
Bay Deck.
(C-2A=1020 cubic feet)
Full Internal Fuel
(18 Passengers)
External Tanks
&
Full Internal Fuel
400
800
1200
1600
2000
2400
2800
3200
Range - N.Mi.



COD RANGE MISSION
OPTIMUM CRUISE SPEED - 380 KTS
VSTOL A
TANDEM LIFT/CRUISE FAN
COD VERSION
OAD
Engine out landing limit
6202 LBS Payload
VTO 47450 LBS, Internal Fuel
(10970 LBS MAX Fuel Weight)
MAX STO Weight Limit, 55350 LBS, with (2) full 400 Gal Tanks
(400 FT. Deck Run, 10 KT WOD)
VTO, 47450 LBS, Internal & External Fuel
Full Internal Fuel
(18 Passengers)
STO, Full Internal Fuel
(10970 LBS) & (2) 400 Gal External Tanks (5440 LBS)
STO Weight Payload
49390 LBS 0
53710 LBS 4320 LBS (18 Passengers)
55350 LBS 6202 LBS
NOTE:
Maximum Payload Will Probably Be Limited By Useable Volume: 640 Cubic Feet (C-2A = 1020 Cubic Feet)
400
800
1200
3200
RANGE - N.Mi.
VTO - Vertical Take Off
STO - Short Take Off

Figure 7

COD CONFIGURATION

CONFIG	TOGW	FUEL (3)	MAX PAYLOAD
VTO	42089 Lb	4986 Lb	7763 Lb
STO	48009 Lb	11206 Lb	6983 Lb

CONFIDENTIAL

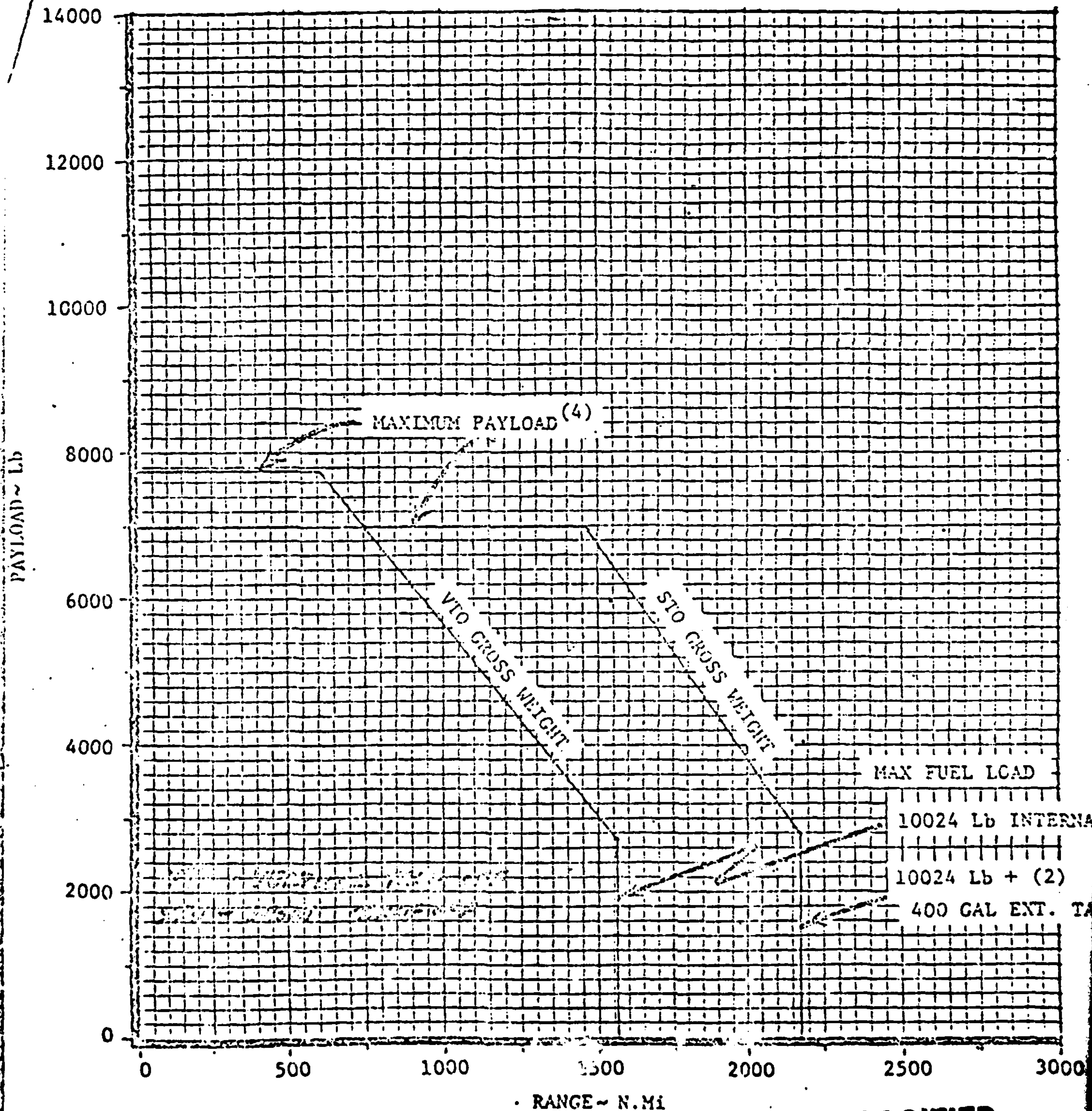


Figure 8

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CONFIDENTIAL

NOTES:

1 - With maximum payload
2 - Cruise at V_{99BRS} at 25000 Feet
3 - Fuel + Payload = 12749 Lb VTO, and 18189 Lb STO.

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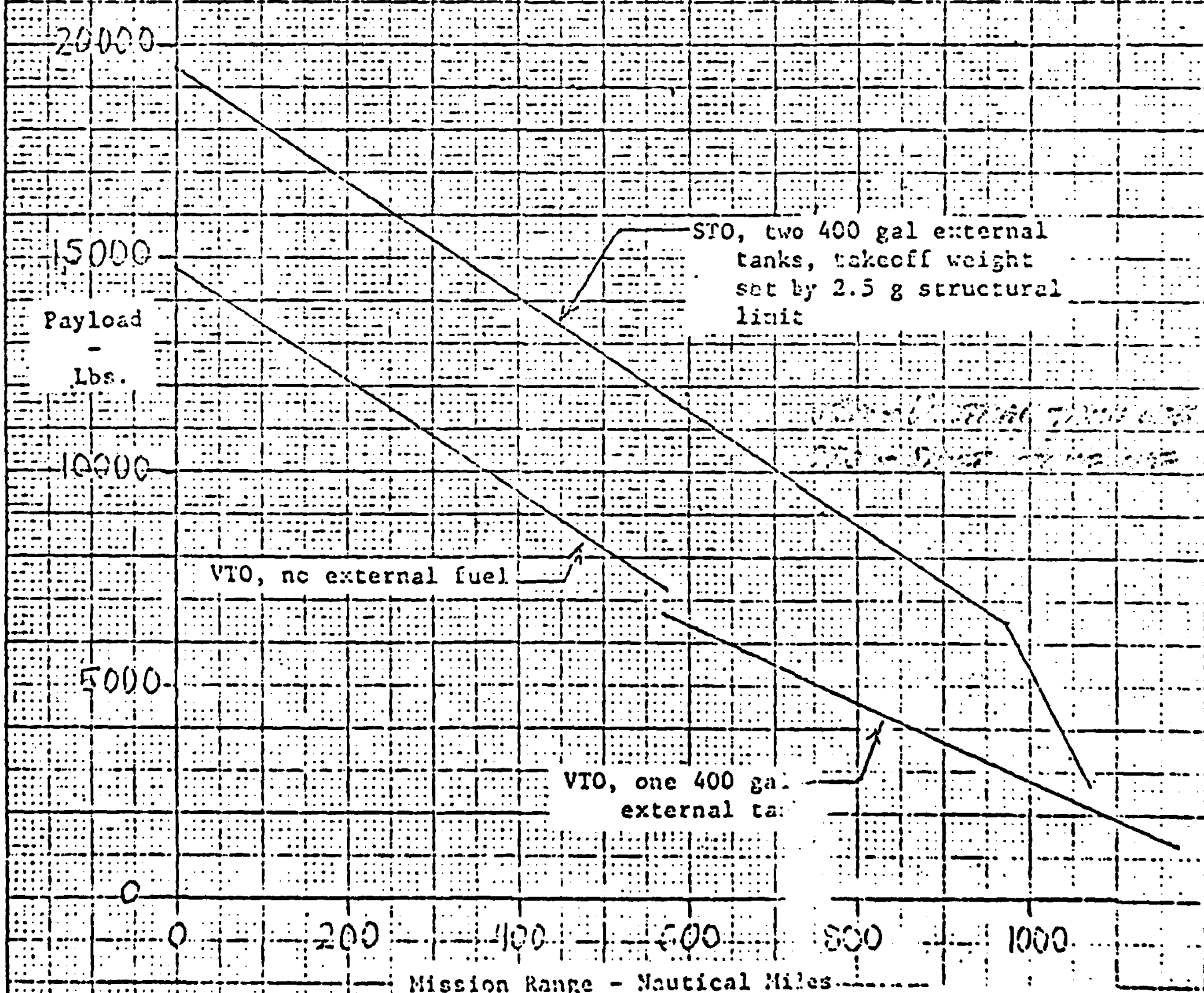
Figure 9

ABC-10-78
SBAMS ABC V/STOL

Carrier Onboard Delivery
Mission Performance

SL, 90° F takeoff
Cruise at best range speed
and altitude



Steven E. Zalesch

APPENDIX A

AIRCRAFT CONFIGURATIONS

IMPROVED C-2

C-2 MODEL 673

US-3A

S-3 COD

C-2 CONFIGURATIONS
CNA COD STUDY 12/5/78

	IMPROVED C-2	DESIGN 673
PROPULSION		
- T56 - 425 Engine	Yes	Yes
- Additional Oil Scavenge Filer	Yes	Yes
- 54460-1 Propeller	Yes	Yes
- Engine Oil Tank (Improved)	Yes	Yes
- Fuel Vent/Dump Interconnect	Yes	Yes
- New Auxiliary Power Plan (APP) fuel feed	Yes	Yes
- New APP: GTCP 165-8 (or-1) or GTCP 95-3	Yes	Yes
STRUCTURE		
- Wing Center Section Skin Thickness Increase	Yes	Yes
- Cargo Door Latches (Redesign for Inf. Life)	Yes	Yes
- Ramp Seal	Yes	Yes
- Center Section Main Beam Upper lock Fitting 123WM 10008 (Local Design Improv.)	Yes	Yes
- Center Section Rear Beam Upper Hinge Fitting 123WM 10010 (Local Design Improv.)	Yes	Yes
- Lower Longeron Beef-up (Arrestment)(Local Design Improv.)	Yes	Yes
- Hoz. Stab. Outboard Extensions		Yes
MATERIAL/FINISH		
- 7070-T6 & 7079-T6 Replacement for improved corrosion resistance	Yes	Yes
- Improved Surface Finishes	Yes	Yes
NAVY APPROVED AIRFRAME CHANGES	Yes	Yes

C-2 CONFIGURATIONS
CNA COD STUDY 12/5/78

	IMPROVED C-2	DESIGN 673
LANDING GEAR		
- E-2C Main Gear Outer Cyliner	Yes	Yes
- E-2C Main Gear Wheels (New)	Yes	Yes
- A-6E Nose Gear Outer Cylinder & separate Drag Brace Link	Yes	Yes
- New Main Gear Door Timer Valve & Redesigned linkage	Yes	Yes
- T-Seals in Main Gear & Wing Fold Actuator	Yes	Yes
- Launch Bar Raise - Pilot Control from Cockpit		Yes
ELECTRICAL/ELECTRONIC		
- Electronic Communication/Navigation Update	*	*
- MIL W-81044 Wiring (SLEP)	Yes	Yes
- Split Bus (Two Channel) Distr. System		Yes
- Single Coil - Double Throw Contactors (F-14 Type)		Yes
HYDRAULICS/FLIGHT CONTROL SYSTEM		
- Stainless Hydraulic Tubing		Yes
- Raychem tube joints & Dynatube fittings		Yes
- Relocation of Elevator Actuator for Access		Yes
- Auxiliary Generator (APP - Driven)		Yes
- 10KVA Emergency Generator (NARF ECP) (SLEP)	Yes	Yes
- Relocation of Hydr. System Components into Nacelle		Yes
- Relocation of Ground Service Panels (Electric + Hydraulic (1)		Yes
- Hydraulic Back Up Modules (2) and Revised hydr. system		Yes
- Isolation Valve piping and logic	Yes	

* See Avionics Suite for CNA Study

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C-2 CONFIGURATIONS

CNA COD STUDY 12/5/78

	IMPROVED C-2	DESIGN 673
RANGE EXTENSION		
- Retractable In Flight Refueling		Provisions
- Increased Center Section Span & Rotated Nacelles		Yes
- Drop Tanks (2 300 gallons)		Yes
FLIGHT CONTROL		
- Auto Pilot Stability Augmentation System Modifications	Yes	Yes
- Increased Trailing Edge down elevator authority	Yes	Yes
- Modification on Wing Leading Edge to improve stall characteristics		Yes
- Additional Aileron Authority (20% more)		Yes
- Revised Flap drive & aileron droop mechanism	Yes	Yes
- Revised lateral feel forces - Reduced 20%	Yes	Yes
COMFORT & UTILITY & SAFETY		
- Improved Sound Proofing	Limited	Yes
- Additional Windows	Yes	Yes
- Comfortable Seats	Yes	Yes
- Improved Lighting (Strip lighting/Emerg. Exit Lights Curb Lights/Ramp Lights)	Limited	Yes
- Stronger Winch - Increased Capacity Winch (C-2 ECP 114) + Longer Cable	Yes	Yes
- Improved Cargo Rails		Yes
- 3rd Crew Seat in Cockpit Door - Jump Seat		Yes
- Engine Cross Bleed Starting System		Yes
- Cargo Door Emergency Exit Handle Illumination	Yes	Yes
- EA-6B Anti-Skid Brake System		Yes
-(Larger Capacity) (Brakes)(EA-6B Common)	Yes	Yes
- Electrical Windshield Wiper		Yes
- Anti-Collision Strobe Light (E-2C Common) (SLEP)	Yes	Yes
- Relocation of Environmental Control System		Yes
- New Instrument Panel Engine Inst. Modern Flight Inst.	Yes	Yes

S-3 CONFIGURATIONS

CNA STUDY 12/5/78

Changes from
S-3A to US-3A

* All redundant functional equipment support structure and redundant secondary shell structure are deleted.

* Left-and right-hand weapons bays are converted to unpressurized cargo compartments.

* A new structural floor is constructed over the existing keelson deck on both the left- and right-hand side in the cabin area.

* Two cabin windows are installed.

* Modifications to the secondary structure of the S-3A airframe are required in all external and internal converted cargo compartments. These modifications consist principally of beef-ups to all fore and aft bulkheads to react cargo loads, the addition of cargo tie-down hard points and the installation of fiberglass compartment liners.

* Addition of an electrically powered hydraulic pump to the No. 1 hydraulic system.

* ASW systems deleted.

* Avionics suite is specified for CNA Study.

* APU fire extinguishers added.

* Rewiring for the following items:

  Emergency hydraulic pump
  APU fire extinguisher
  High intensity strobe light
  Cabin lighting
  New avionics suite

* Major modifications to ECS

* Improved acoustical insulation

* Additional of 5 passenger seats and a folding seat over entrance.

* Four escape hatches are provided (explosive opening).

* Oxygen provisions for passengers and crew chief.

* Addition of 2 MK7 life rafts.

S-3 CONFIGURATIONS

CNA STUDY 12/5/78

FOR "FAT ALBERT" MODEL CL1236-14
(S-3 COD)

S-3A components that are essentially unchanged

* Wing, engine package and engines
* Vertical tail above fold line
* Horizontal tail outboard of the center section
* Flight station
* Nose landing gear
* Main landing gear rolling stock
* Provisions for pylons and external fuel tanks

Changes to S-3A

* Fuselage aft of the flight station is a new design to provide additional space and cargo ramp loading door.
    * Fuselage length increased 51 inches over the S-3A forward of the wing
    * Width increased 86 to 96 inches
    * Wing and empennage raised 16 and 19 inches respectively to provide additional room
    * Fuselage body aft of the wing is recontoured
    * Horizontal tail is lengthened through the installation of a 16 inch center plug
    * The landing gear is redesigned.

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EMPTY WEIGHT BREAKDOWN

CNA COD STUDY 12/5/78

	S-3A	US-3A	Current US-3A 3007
Wing Group	4890	5000	4911
Tail Group	1354	1341	1297
Body Group	5068	5509	5033
Alighting Gear	1700	1684	1680
Flight Controls	1604	1619	1608
Nacelle	805	788	787
Propulsion	3485	3471	3474
Aux. Power	255	264	263
Instruments	174	173	176
Hydraulics	389	437	443
Electrical	832	922	849
Electronics	4353	1287	1399
Furnishings & Equipment	860	817	1175
Air-Cond & Anti-Ice	959	905	854
Aux. Gear	283	283	283
Armament	357	20	16
	27368	24520	24248

DCPR WEIGHT BREAKDOWN

CNA COD STUDY 12/5/78

	S-3A	Current US-3A 3007
Wheels, Tires, Brakes	488.4	480.1
Main Engines	2952.2	2943.8
Starters	49.4	49.4
APV	115.2	115.2
Instruments	101.0	101.0
Batteries, Power Supply	231.4	231.4
Avionics	3326.5	877.6
Air cond. & Anti-Ice	195.6	195.6
Hydraulic fluid	63.0	63.0
Total	7522.7	5057.1
Weight Empty	27368.0	24248.0
- Total	7522.7	5057.1
DCPR Weight	19845.3	19190.9

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AVIONICS SUITE FOR

THE CNA COD STUDY 12/5/78

NAVIGATION	US-3A	IMPROVED C-2
VG System	ID-1481/A (2)	ID-1791 (2)
AHR S	ASN-107	A24G-39
TACAN	ARN-84	ARN-118
UHF ADF	ARA-50	ARA-50
LF ADF	ARN-83	ARN-83
AIR DATA COMPUTER	AYN-5	CP-957A
RADAR	BENDIX RDR-1300	APS-121
RCVR DECODER	ARA-63	ARA-63
MARKER BCN/GS	VIR-31A	VIR-31
OMEGA	ARN-131	ARN-131
DOPPLER	APN-200	APN-200
RADAR ALT.	APN-201	APN-171
ALT. INDICATOR	AAU-21 & 24	AAU-21 & 24
AFCS	ASW-33	ASW-15
CAINS	ASN-92 (3 box)	ASN-92 (5 box)
INSI	ASA-84	

COMMUNICATION	US-3A	IMPROVED C-2
HF COM	ONE ARC-153	ARC-174
UHF COM	TWO ARC-156	TWO ARC-182
VHF TRANSCEIVER	ARC-175	REPLACED BY ARC-182
IFF TRANSPONDER	APX-72	APX-100
IFF COMPUTER	KIT 1A/TSEC	KIT-1/TSEC
ICS	OK 248 V/A1(MOD)	AIC-14
DATA LINK	ASW-25B	ASW-25B
RADAR BEACON	APN-202	APN-202
BCN AUGMENTOR		R-1623/APN
FLIGHT REC/BCN LOCATOR		ASH-20
UHF CRYPTO	KY-28	KY-28

APPENDIX B

OPERATING AND SUPPORT COST DATA

Figure 1

O&S COST FACTORS, COD CANDIDATE AIRCRAFT, FY 1979 $

COST PER AIRCRAFT

CES	CH-53D	CH-53E	Model 673	Improved C-2	US-3A	S-3 COD
Personnel 1/	293,053/yr	293,053/yr	261,359/yr	261,359/yr	261,359/yr	261,359/yr
Officer	93,865/yr	93,865/yr	74,666/yr	74,666/yr	74,666/yr	74,666/yr
(No.)	(4.4)	(4.4)	(3.5)	(3.5)	(3.5)	(3.5)
Enlisted	199,188/yr	199,188/yr	186,693/yr	186,693/yr	186,693/yr	186,693/yr
(No.)	(22.0)	(22.0)	(20.62)	(20.62)	(20.62)	(20.62)
Depot Maintenance						
Airframe	52,000/yr	52,000/yr	187,794	185,560/yr	109,981/yr	108,111/yr
Engine	157.06/FH	235.60/FH	56.43	56.43/FH	53.38/FH	53.38/FH
Component	560.07/FH	544.58/FH	107.98	105.29/FH	141.52/FH	202.56/FH
Replen. Spares	68.86/FH	71.15/FH	13.63	12.99/FH	19.48/FH	25.80/FH
Operating Consumables						
POL 4/	118.80/FH	192.00/FH	120.13	108.40/FH	79.60/FH	109.20/FH
Other	204.61/FH	254.18/FH	153.93	149.76/FH	195.59/FH	241.47/FH
Subtotal Direct $/AC/YR 2/	1,010,693/yr	1,123,559/yr	720,413	706,641/yr	665,082/yr	748,916/yr
Indirect 3/	423,802	468,566	267,008	263,212	260,062	285,227
Total $/AC/YR 2/	1,434,495	1,592,125	987,421	969,853	925,144	1,034,143

1/ CH-53D and E manpower based on 12 aircraft/squadron, C-2 and S-3 configurations manpower based on 10 aircraft/squadron.

2/ Based on 50 FH/AC/MO.

3/ Indirect Costs include: Logistics, Base Ops, Training, Health, Recruit and Examine, Officer Transient, Officer Holding Account, PCS.

4/ JP-5 fuel priced at $.40/gal, consumption rates provided by AIR-530.

Figure 2a

OPERATING AIRCRAFT

FLIGHT HOURS/MONTH = 50.00 AIRCRAFT/SQUADRON = 10

FY	DELIVERED AIRCRAFT	AVE OPER AIRCRAFT	FLIGHT HOURS
1983	12	5.00	3,000
1984	12	15.00	9,000
1985	12	25.00	15,000
1986	0	30.00	18,000
1987	0	30.00	18,000
1988	0	30.00	18,000
1989	0	30.00	18,000
1990	0	29.00	17,400
1991	0	27.00	16,200
1992	0	25.00	15,000
1993	0	24.00	14,400
1994	0	24.00	14,400
1995	0	24.00	14,400
1996	0	24.00	14,400
1997	0	24.00	14,400
1998	0	24.00	14,400
1999	0	24.00	14,400
2000	0	24.00	14,400
2001	0	24.00	14,400
2002	0	24.00	14,400
TOTAL	36	486.00	291,600

Figure 2b

O&S COSTS FOR C-2 AND S-3 VARIANTS
FY 79$

	$/AC/YR	Total O&S $ (000's)
C-2 model 673	987,421	479,886.6
Improved C-2	969,853	471,348.6
US-3A	925,144	449,620.0
S-3 COD	1,034,143	502,593.5

1 - With maximum payload
2 - Cruise at V_{99BRS} at 25000 Feet
3 - Fuel + Payload = 12749 Lb VTO, and 18189 Lb STO.

END

DATE FILMED

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